

Does contracting method matter? A comparative analysis of quality and performance outcomes in multi-prime vs single-prime urban roads infrastructure construction

Abstract

This study explored the difference in quality performance outcomes between Multi-Prime and Single Prime contracting methods and Multi prime contracting methods as they are used in roads infrastructure construction in Nairobi City County in Kenya. The study adopted cross-section study design in which primary quantitative data was collected from roads infrastructure construction professionals using semi-structured questionnaire. The study targeted a sample size of 385 rods construction professionals. Non-probability sampling methods (Purposive and snowball) were used to select and recruit the study participants. The Cronbach's alpha for contract quality performance was 0.713, which indicated that the construct for measuring quality performance was reliable. With a Cronbach's alpha of 0.615, overall contract performance demonstrated acceptable reliability. A statistically significant difference was observed in the quality of project output between Single Prime and Multi prime contracting methods ($U = 495.0$, $z = -1.152$, $p = 0.002$). The significantly higher mean rank for single-prime (38.91) compared to multi-prime (46.46) indicates that multi-prime contracting is associated with higher quality project outputs. The difference in overall contract performance between the two methods was not statistically significant ($U = 701.500$, $z = -1.228$, $p = 0.019$). Interestingly, despite the seemingly lower quality output, Multi prime contracting showed a slightly higher mean rank (45.87) compared to Single Prime (39.32) in overall performance. The result suggests that single prime contracting may actually be associated with, lower quality possibly due to the prime contractor's markup on subcontractor work. This study concludes that multi-primers performs better than single-prime contracting methods in term of cost and overall performance in large and complex road construction projects in Nairobi City County-Kenya.

Keywords: single prime contracting, multi prime contracting, quality performance

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Introduction

Roads infrastructure construction has been considerably a critical pillar of socio-economic development in Kenya. Most development indicators have often used roads network coverage as an indicator of economic development and as remained as major target project that the government in investing on. Nevertheless, the long run quality performance of some of road have been questionable because they wear out sooner than expected.^{1,2} Arguably, contracting methods have been a contributing factor on the overall quality performance outcomes.³ Various contracting methods have been commonly used in Kenya but the main one being prime contracting.⁴ Prime contracting involves the owner (client) hiring a primary contractor (prime contractor) to preside over the execution of the entire project or a significant portion of the construction. Prime contracting can be implemented in two main formats namely single-prime contracting and multi-prime contracting. In either case, the prime contractor is the primary contact person responsible for managing all the dimensions of the project.⁵

Prime contractors act as the only point of contact for the client. The prime contractor therefore executes management of subcontractors, procurement of materials, and certifying that the project complies with project requirements and guidelines. Moreover, the prime contractor takes a substantial fraction of the project implementation risks such as quality control issues, cost overruns and delays. The prime contractor

enters into a contractual agreement with the client, which outlines the deliverables, quality, costs, timelines and other project details.⁶

Single-prime and Multi-prime contracting are two distinct approaches in prime contract construction project management. In single-prime contracting, the client engages with one general contractor (GC) responsible for implementation of the whole project. The GC thus presides over all dimensions of the project by hiring subcontractors, plans and coordinates schedules, and ensures the project is implemented in line with the standard guidelines and specifications. Additionally, the GC oversees quality control.^{4,7} Where subcontractor are involved, the GC coordinates all of them to ensure that the project delivery process is streamlined and the project is implemented efficiently. In this contracting method however, the client has limited control over the selection and procurement of the subcontractor. Consequently, the contracting method is vulnerable to higher costs because the processing of contracting is not fully transparent to the client.⁸

Additionally, single prime contracting is based on fixed-price contract and thus, the GC takes the liability of completing the project for a set amount of money, within a certain period of time and meets the quality dimensions of the project. Moreover, the GC is liable for most of the risks associated with the pre-construction, the actual construction process and any immediate post construction quality related issues which might arise including poor quality performance.⁸

To minimize the risk of poor quality performance, the GC must coordinate all sub-contractors, suppliers and laborers to ensure the materials, the laborer, the process and deliverables meet quality thresholds. The GC, must take responsibility so that the project meets the quality specification and standards including any legal regulations, obligation and liabilities binding the GC and the client.⁹

Single-prime contracting model can often be confused with Design-Bid-Build (DBB) model. In DBB the project is divided into three distinct stages namely, design, bid, and build. In DBB model, the client hires a designer who instruct to design the project to their taste (client's taste). When they reach a consensus, the designer does and delivers his work and their contract end there. The Client then puts out the project out for bidding and construction contractors are invited for the bidding. The contractor who wins the tender is awarded the contract for construction of the project to its delivery based on a complete set of construction documents including the design. The client therefore holds different contracts with the designer and the contractor.^{4,10} The main difference between Single-prime and DBB model is that, in the formers, a single contract binds the owner and the prime contractor, whereas in the later DBB, different contracts for design and construction binds the clients and the contractors (designer and constructor).

In the construction of the Thika Super Highway for example, the Kenyan government contracted major construction firms: China Wu Yi, Sinohydro Corporation Limited; and Shengli Engineering as the main contractors for different lots starting from Uhuru highway to Muthaiga roundabout (Lot 1), from Muthaiga roundabout to Kenyatta University (Lot 2) and finally from Kenyatta University to Thika town respectively (Lot 3). These contractors, managed everything in their Lots, including subcontracting specific tasks like road marking, electrical installations and maintenance. This approach simplified management and allowed for a focused execution strategy, essential for the project's quality completion for the value for money.¹¹

Multi-prime contracting on the other hand, involves the client directly contracting with multiple specialty contractors (e.g., construction, electrical, plumbing, fitting, finishing and furnishing etc) as opposed to a single GC as in the case of single-prime. The coordination of the project is done by either the owner or a construction manager or in collaboration with each other.¹² Because the client has a direct control over the selection and recruitment of contractors, multi-prime contracting can be cost saving because the client can negotiate for the cost of the project. Additional cost saving may be realized through the more transparent bidding process for each trade needed in the delivery of the whole project. With the multiple involvement in the bidding process, where the client is directly involved, the quality performance of the project is enhanced because the contractors know that the client is directly involved. The quality performance is driven by enhanced accountability and transparency in both bidding process and procurement of materials.⁷ In the arguments of⁸ however, multiple prime (MP) contracting method invites involvedness of coordinating and managing several contractors, which might instigate scheduling disputes and challenges with communication because both the client and the main contractor are significantly involves in similar or closely related roles.⁷ The Kibera Slum Upgrading Project in Nairobi for instance adopted multi-prime contracting. The Kenyan government, together with International agencies such as UN-Habitat (United Nations Habitat), directly contracted different local contractors for different facets of the project including housing construction, electrical installations and sanitation infrastructure. Through this method enabled use of specialized skills for the various facets of

the projects. Consequently, quality performance of the project was heightened.⁹

Often, multi-prime contracting can be confused for management contracting. Management contracting is a contracting method in which the client contracts a construction manager to take charge of the project. The construction manager takes the responsibility of implementing the project by procuring sub-contractors on behalf of the client. The client mainly holds contracts with the construction manager in in some instances, with sub-contractors for different trades.¹² The management contractor provides expertise as well as oversight. The client or the manager may hold direct contracts with subcontractors. In multi-prime contracting, the owner holds multiple contracts with specialty contractors, while in management contracting, the owner primarily contracts with a management contractor who then fully controls the subcontractors.^{8,13} Consequently, in management contracting, the management contractor takes a more comprehensive responsibility in overseeing the implementation of the entire construction, from the design stage to completion. As highlighted earlier, in multi-prime contracting, the client and/or construction manager takes the role of coordinating the implementation. Notably, multi-prime contracting gives the client more direct control over the individual sub-contractors but is more demanding. Management contracting on the other hand centralizes coordination in the hand of management contractor, and thus simplifies the project management for the client.⁸

Kenya's motivated infrastructure development in roads construction sector is crucial for accelerating economic growth, connectivity, and regional integration.¹ The strategic importance of these projects notwithstanding, they are frequently characterized with various challenges including cost overruns, time delays, and inconsistent quality of outputs.¹⁰ Poor quality of output in the roads sector not only creates traffic problems but also forces the government to budget for repairs of roads. Poor quality of roads means that the roads fail the test of time, as some of the roads wear out sooner than expected.¹⁵ These issue not only strain public resources but also makes the roads less effective and efficient to use. In some cases poor quality of roads makes the roads dangerous more so where the roads are not properly marked, the road bumps are not built to standard or are not marked as required, exits and entries are not properly marked, pavements are not provided or demarcated and basic warning are not indicated. Central to the execution of these projects is the choice of contracting methods, which can significantly influence their performance. Large infrastructure projects, such as the Standard Gauge Railway (SGR) and various road construction initiatives, have consistently faced delays and poor quality of output.¹⁰

Several studies and published reports have documented the prevalence of cost overruns, delays and low quality in some Kenya's roads infrastructure projects. A World Bank study on infrastructure in Kenya for example, highlighted that the costs and cost overruns are a common issue but the quality of delivery do not match the costs. Some of the projects exceeded their original budgets by substantial margins not reflected in the quality of the output.¹⁶ A report by the African Development Bank (AfDB) highlighted that infrastructure project cost overruns could be attributed to factors such as poor project planning,^{17,18} inflation and frequent design changes during project execution among other issues.¹⁹ Cost overruns increase the financial burden on the sponsors of the project and also delay the benefits that the infrastructure targets to deliver to the end user. Quality of output is another critical concern. The Kenya Institute for Public Policy Research and Analysis (KIPPRA) report in 2020 indicated that many road infrastructure suffer from inferior workmanship, leading

to roads that deteriorate within a short time and necessitate repeated repairs to sustain their use. Among the factors which contribute to the substandard quality issues include deficient supervision, use of poor quality materials or incorrect use of construction materials and haphazard adherence to construction quality standards. The SGR project for instance, was criticized over quality concerns, with reports of subservient materials being used. In the long run, the longevity and safety of the infrastructure is arguably compromised.²⁰

Although both multi-prime and single-prime contracting methods are extensively used in Kenya, there is a scarcity of comparative research their performance outcomes in large road construction projects in terms of quality of output. More specifically, there is limited scholarly evidence on how these contracting methods influence the quality of the projects upon completion. Given the substantial investments in the road infrastructure sector in Kenya, it is imperative to understand how effective the two contracting methods are in terms of quality of output.

This study was inspired by the question; Does contracting method matter? Consequently the study aimed at filling this gap by conducting a comparative analysis of quality performance between multi-prime and single-prime contracting methods in large road infrastructure construction projects within Nairobi City County, Kenya. The main objective was thus to establish whether single prime or multiple prime contracting methods performs differently in terms of quality of output. By examining quality outcomes, this study sought to pinpoint which contracting method offers better performance. The findings deliver invaluable intuitions for policymakers, construction managers, clients and stakeholders in Kenyan roads infrastructure sector. The study will thus facilitate nobler decision-making and strategic planning for similar projects.

Literature review

Roads infrastructural development has been part of the government development agenda and this has seen increase in construction projects in Kenya. There is therefore an increasing need to ensure that the contractors involved in the projects fulfil their obligations including the construction within the quality standards specifications and within the budget and time limits.

There has been a delay in delivery of various large projects and this has resulted in an increase in construction costs and even further having impact on the quality.²¹ This can partly be attributed to the contracting method employed in the execution of the projects.^{22,23} Reports on the Thika Superhighway for example highlight cost and time overruns and delays due to various factors, including scope changes and land acquisition issues.¹⁹ Notably, the project was implemented through Single Prime contracting of three contractors.

Most of the large infrastructural developments are vision 2030 flagship projects and to realize this a mechanism must be put in place to ensure that the projects are delivered within the budget. Single prime contracting has been the prevalent conventional way of contracting method in Kenya.²⁴ This is where the client or the developer chooses one contractor to execute the various phases of the works. Due to rise in upcoming large construction projects there has been need to have the projects delivered on time and within the expects costs and quality of output.

Kim's research on "Project performance evaluation of multi-prime contracts in comparison with general contractor contracts"⁸ delved on multi-prime contracting, as an alternative to general contractor contracts. In his study, Kim considered two pilot construction projects

which were implemented under multi-prime contracts with direct owner involvement. The projects' performance in terms of cost, schedule, and quality (defects and participant satisfaction) under the multi-prime contracts was compared to a general contractor contract which is single prime (SP) contracting. The results from the study indicated that multi-prime registered lower cost by eight percent. However, quality and time of delivery did not differ significantly between single-prime and multi-prime contracting methods.²⁵

According to Ofori G,²⁶ the major problems facing Ghanaian contractors and consultants were closely related to the ones faced by contractors in most third developing or underdeveloped countries. Ofori established that the challenges which influenced the quality performance of Ghanaian contractors in the roads construction sector included limited ability to access and secure sufficient and reliable working capital, hiccups in organization, engineering incompetence and poor workmanship. It was evident limited capital incapacity most constructors in terms of securing the right tool, equipment and machinery required to maximize quality of work. The same limitation exposed the contractor to using cheap labor characterized with limited knowledge, skills and expertise required to optimize quality. It is evident that from this study that quality performance was mainly a function of limited capacity (both financial capital and human resource) and thus would most likely lead to poor quality performance. The study also noted that general contractors are more likely to suffer from capacity hiccups compared to multi-prime contracting because in multi-prime contracting, each specialty contractors come with their own capacities.

According to Kim K,⁸ there have been substantial deliberations as to whether the use of multi-prime contracting or general contractor contracting is the most apposite in roads infrastructure construction projects. Generally, in most projects, GC contracts are preferred, while specialty contractors prefer multi-prime contracts. General contractors on the other hand argue that multi-prime contracts are characterized with higher bidding costs, more change orders, increased administrative expenses, more claims, and but fairly good quality.²⁷ In contrast, the specialty contractors contend that GC contracts result in relatively higher overall costs but lower quality,⁸ with general contractor contracts resulting in 2.75 - 9.54 percent higher costs than multi-prime contracts. Thus, previous studies have attempted to determine the cost and quality performance differences between multi-prime and general contractor contracts. According to Dissanayaka SM,²⁸ it is essential to understand the factors that can potentially impact quality performance of roads infrastructure so that project managers can focus on practices which would be cost effective and meets the quality standards.

In the road sub-sector, the frequency of cost and time overruns across projects in Kenya is significant. As of February 2007, 16.91% (35 out of 207) ongoing projects experienced cost overruns, amounting to Kshs. 7 billion. In terms of time overruns, 184 projects exceeded their originally agreed completion times set at the tender stage. On average, the actual completion time was more than double the time estimated during tendering.¹⁶ Data from KeNHA on a few road construction projects have shown delays in completion. For example, the Rehabilitation and Construction of the Londiani-Fortenan Muhoroni Road²⁹ was awarded on April 27, 2010, with a commencement order issued on June 22, 2010. The initial completion period was set at 24 months, with a completion date of July 19, 2012. However, the project was finished 8 months later than planned. Similarly, the Construction of the KCC (Sotik) – Ndanai – Gorgor Road also experienced delays.³⁰ The contract, initially scheduled to commence on September 7, 2011, and conclude by September 6,

2013, had its completion date extended to February 7, 2014, resulting in a time overrun of six months.^{8,21} Time and cost overruns in road construction projects in Kenya under Kenya National Highways Authority. The Homabay-Mbita road, situated in the Homa Bay and Suba Districts of Nyanza in Western Kenya, began construction on February 5, 2010, with an initial completion period of 30 months, targeting an end date of August 3, 2012. However, the completion date was first extended to October 23, 2013, and later further revised to January 13, 2014.²¹

Theoretically, Multi-prime and single-prime contracting are characterized with significant difference in internal resources and capabilities which would translates into their quality of their deliveries. According to resource-based view and dynamic capabilities theory, performance is a function of unique resources and diverse abilities.³¹⁻⁴³ Where an entity has more powerful and unique resources as well as dynamic abilities, they are more likely to perform better and thus deliver superior quality in terms of infrastructure development.⁴⁴⁻⁴⁷ Multi-prime contractors for example comprises of different contractors who have specialized in various trades and may have access to deeper pools of specialized resources. Sing-prime contractors may have more control over critical resources like personnel, technology, equipment and easier resource coordination but might not be lesser scope of specialization in various trades involved in roads construction.

The cost overruns and quality of output are critical parameters in measurement of performance of contractors involved in the delivery of roads infrastructure because the same are the most critical for measurement of value for money invested. Cost overruns adds financial burden on the funders and government while substandard quality translates to losses by government, users and the contractors themselves because the poor quality taint the reputation of the contractor. It is consequently essential to examine the contract performance in terms of cost and quality of output. By establishing the differences in quality performance more specifically, between single-prime and multi-prime contracting methods, this research aimed to establish which method would be the most preferable for sustainable and desirable quality at the cost of investment in Nairobi City County and Kenya at large.

Materials and methodology

This research adopted cross-sectional case study design to evaluate the quality performance of roads infrastructure projects which have been implemented through the two contracting methods (single-prime contracting and multi-prime contracting). The study population comprised, project Architects of active construction projects, Project Engineers and Project Managers in Nairobi City County. According to KURA there have been 26 road constructions in Nairobi County between 2012 and 2022, with 14 of them at least 95% completed.³³ Together with the express way, there have been at least 27 roads under construction in Nairobi County between 2012 and 2022. This study therefore sampled road construction professionals who have been involved in the projects as identified by KURA. These professionals included architects, consultants, and engineers from road agencies, contractor representatives, administrators, construction managers, and construction technicians. In this study the sample size was calculated using Cochran’s formula. Here’s an explanation of Cochran’s formula and how to use it:

$$\text{Cochran's formula: } n = \frac{z^2 * p(1 - p)}{e^2}$$

Where: n = sample size

Z = z-score corresponding to the desired confidence level (1.96 for 95% confidence level)

p = estimated proportion of the population with the desired attribute (= 0.5)

e = desired margin of error (e.g., 0.05 for ±5%)

$$\text{Cochran's formula: } n = \frac{1.96^2 * 0.5(1 - 0.5)}{0.05^2}$$

$$n = 384.16 \approx 385$$

The study adopted purposive and snowball sampling since it allowed for use of cases which meet the desired criteria in terms of the data needed to answer the research objective. Snowball sampling was used to select the specific professionals who were directly involved in the roads infrastructure projects. Due to the complexity of the scenarios (for completed construction), convenient sampling was adopted to select the hard-to-reach population (professional who were involved in the completed projects). The contractors who implemented the projects were contacted and asked to refer the researcher to the targeted professionals. The professionals who were reached to and gave voluntary consent to participate were also asked for references. This was repeated until the researcher exhausted all the accessible participants who were willing to take part in the study. Case study sampling was also used as an investigative model to identify the contracting methods that delivers better quality of output. All the study participants were inducted in details to ensure that they fully understood the difference between single prime contracting and multi-prime contracting. Examples were used for further clarification to enhance the understanding of the participants of the difference between the contracting methods. Etikan, and Bala,³⁴ defined a sample as a representative fraction of a population of interest. According to McCready WC,³⁵ sampling procedure is the process of selecting a specific number of respondents for a study”. To minimize biasness that would result from purposive and snowball sampling, the researcher ensure that at least all the categories of the targeted study participant were sampled and selected. Consequently architects referred the researcher to fellow architects, consultants referred the researcher to fellow consultants. The same trend was applied for the other professionals namely engineers from road agencies, contractor representatives, administrators, construction managers, and construction technicians.

The study therefore expected to achieve 385 responses from completed road construction projects in Nairobi between 2012 and 2022 (Table 1).

Table 1 Sampling framework

Category	n	Percentage
Construction technicians	9	2.3
Administrators	22	5.8
Architects	31	8.1
Construction managers	45	11.6
Consultants	54	14
Contractor representatives	89	23.3
Engineers and other professionals (QS, QA) from road agencies	135	34.9
Total	385	100

Results and discussion

The study targeted 385 participants out of which 267 participants voluntarily consented and participated in the study. Therefore, 267 questionnaires were successfully filled and returned, yielding a response rate of 67.01 percent. This response rate met the threshold considered sufficient as recommended.³⁶ Accordingly,³⁶ although bigger sample size presumably yields more accurate results, 50% response rate is adequate to answer research questions. The data collected was processed and analyzed using SPSS (Statistical Package for Social Scientists) version 26. The sample size for the study included 93 engineers Qs and QAs, 6 construction managers, 62 contractors/representatives, 16 contract administrators, 31 architects, 22 foremen, and 37 construction technicians were considered for the study totaling to 267 respondents. The 267 participants represented both multi-prime and single prime contracting as shown in the demographic characteristics of the study participants (157(60.6%) represented single prime contracting while 102(39.4%) represented multi prime contracting).⁴⁸

The Cronbach's alpha for contract quality performance was 0.713, which indicated that the construct for measuring quality performance was reliable. This suggests that the items measuring contract quality performance had high degree of internal consistency. With a Cronbach's alpha of 0.615, the construct for measuring contract performance did not meet the recommended threshold but it is interpreted as fairly acceptable.⁴³ Recommends that for exploratory complex social science research social an $\alpha \geq 0.6$ demonstrates acceptable reliability. This level of internal consistency is generally considered adequate for exploratory research, but further refinement of the scale would enhance its reliability (Table 2).

Table 2 Reliability test statistics

Construct	Cronbach's Alpha	N of Items
Quality performance	0.713	6
Contract performance	0.615	5

Demographic characteristics of participants

The findings showed that female respondents were females, 72(27.3%), 189(71.6%) were males while a minority of 3(1.1%) identified with other gender not disclosed. The gender distribution seems "biased" but is justifiable by the general gender distribution of gender in the construction industry in developing and underdeveloped countries where gender division of labor is common. Evidence show that Construction industry is generally male dominated and therefore the gender distribution in this study does not expose the results to study bias on gender.⁴⁹ A majority of the participant were aged 26 -35 years (30.7%), followed by 36-45 years 66(25.0%), 46-55 years 51(19.3%), 18-25 years, 45(17.0%) and 56 and above years, 24(9.1%). The study also examined the educational achievement of the respondents. The study established that majority of them were bachelor's degree holders 126(47.2%), followed by Master's degree holders 99(37.1%). About 27(10.1%) had doctorate degrees while the minority 15(5.6%) identified with unspecified education achievements. In terms of years of experience in their trades of practices, majority 99(38.8%) had had been in their fields for 4-6 years, followed by 1-3 years, 75(29.2%) and 54(20.5%) who had between 7 and 10 years of experience in valid responses. A small proportion; 27(10.2%) had been in their fields for ten or more years. With regards to the category of the contracting method employed in the projects they worked on, 157(60.6%) represented single prime contracting while 102(39.4%) represented multi prime contracting among the valid responses. This observation

indicates that there is a possibility of more preference for single prime contracting method than multi prime contracting.

From the demographic characteristics, it was observable that the participants were fairly educated and experienced such that they would be adequately informed to understand the two contracting methods under study. According to Oyetunji, and Anderson,³⁷ higher level of education attainment and long experience are critical in understanding the dynamics, frameworks, concepts and the landscape in a professional's services. The argument advanced is that education and experience are imperative for exposing people to a large scope of knowledge and understanding necessary for appreciation and delivery of quality of output. These results are summarized in Table 3.

Table 3 Demographic characteristics of participants

		Frequency	Percent	Valid percent
Age				
Valid	18-25 years	45	16.9	17
	26-35 years	81	30.3	30.7
	36-45 years	66	24.7	25
	46-55 years	51	19.1	19.3
	56 and above years	24	9	9.1
	System	3	1.1	
Total		267	100	100
Gender				
Valid	Male	189	70.8	71.6
	Female	72	27	27.3
	Other	3	1.1	1.1
	Total	264		100
Missing	System	3	1.2	
Total		267	100	
Education				
Valid	Bachelor's degree	126	47.2	47.2
	Master's degree	99	37.1	37.1
	Doctorate	27	10.1	10.1
	Other	15	5.6	5.6
	Total	267	100	100
Years of experience in construction industry				
Valid	1-3 years	75	28.1	29.2
	4-6 years	99	37.1	38.8
	7-10 years	54	20.2	20.5
	More than 10 years	27	10.1	10.2
	Total	264	98.8	100
Missing	System	3	1.1	
Total		267	100	
Contacting method of the most recent project				
Valid	Single prime	157	58.9	60.6
	Multi prime	102	38.2	39.4
	Total	259	96.5	100
Missing	System	8	3.5	
Total		267	100	

Descriptive statistics (Appendix)

Quality performance

This study examined the perceived quality of project outputs under Single Prime and Multi-Prime contracting methods. Data was collected using a 5-point Likert scale (1 - Strongly Disagree,

2 - Disagree, 3 - Neutral, 4 - Agree, 5 - Strongly Agree) across six key quality indicators. The results provide valuable insights into the perceived quality outcomes of construction projects under these contracting methods.

On the question of “Project Incorporated Innovative Practices”, the mean (\bar{x}) = 3.33, Std Dev (σ) = 0.789, N = 258, shows the lowest mean score among all quality measures. The result suggests that participants have a slightly positive view of the incorporation of innovative practices in projects, leaning towards a neutral stance. The notably lower score for innovative practices (3.33) suggests this as an area where both contracting methods might have room for improvement. This could indicate a tendency towards more conservative, tried-and-tested approaches in construction projects, possibly at the expense of innovation. One area which has not been exhausted is mechanization, automation and robotization as is common in first world countries.⁴⁸

On the second question “Project Conforms to Specifications” The mean, \bar{x} = 4.01, σ = 0.642, N = 258 indicates strong agreement that projects conform to specifications. The relatively low standard deviation suggests consistency in this perception across respondents. The results of the analysis on the “Outcomes are Durable and Long-lasting” \bar{x} = 4.08, σ = 0.723, N = 258 indicating very strong agreement that project outcomes are perceived as durable and long-lasting. On the question of “Outcomes Comply with Regulatory Standards” The mean, \bar{x} = 3.86, σ = 0.722, N = 258 shows that the respondents generally agreed that project outcomes complied with regulatory standards, though less strongly than for specifications conformity and durability. The mean of “Stakeholder Satisfaction” question, \bar{x} = 4.02, σ = 0.756, N = 255 also shows strong agreement regarding stakeholder satisfaction with project outcomes, suggesting high perceived quality from a stakeholder perspective. Quality of Workmanship \bar{x} = 4.00, σ = 0.577, N = 255 Respondents strongly agree about the high quality of workmanship, with the lowest standard deviation indicating high consistency in this perception.

The highest scores are observed in durability (\bar{x} = 4.08), stakeholder satisfaction (\bar{x} = 4.02), conformity to specifications (\bar{x} = 4.01), and quality of workmanship (\bar{x} = 4.00). These represent traditional measures of construction quality and suggest that both contracting methods are perceived to perform well in these fundamental aspects. The overall mean (\bar{x} = 3.88) nevertheless indicates that the participants in the study were either neutral and almost agreed that the projects qualities in the two contracting methods were good. Table 4 summarizes descriptive statistics.

The high overall quality perception suggests that both Single Prime and Multi-Prime contracting methods can deliver high-quality project outcomes. This challenges the notion that one method is inherently superior to the other in terms of quality delivery. While traditional quality aspects are well-addressed, there’s a clear opportunity for enhancing innovative practices in construction projects, regardless of the contracting method used. The results indicate that a holistic approach to quality, encompassing technical aspects (durability, specifications), regulatory compliance, and stakeholder satisfaction, is being achieved. The consistency in quality perceptions suggests effective quality management practices are in place. Project managers should focus on maintaining these high standards while exploring ways to foster innovation.

Overall contract performance

This study evaluated the overall contract performance in construction projects by asking participants to rate various aspects of performance on a Likert scale from 1 (Very Poor) to 5 (Excellent). The aspects assessed included financial performance, time performance,

overall quality of output, compliance with safety standards, and utilization of resources. Table 4 summarizes the results, presenting mean scores and standard deviations for each performance aspect. The mean, \bar{x} = 3.41 on financial performance indicates that financial performance was rated as “Moderate” to “Good.” The relatively low standard deviation of σ = 0.658 suggests consistency in perceptions of financial performance across projects, indicating generally satisfactory financial outcomes. On measurement time performance, the mean, \bar{x} = 3.00, time performance was rated as “Moderate.” The standard deviation σ = 0.831 points some variability, suggesting that while some projects met time expectations, others experienced delays.

Table 4 Contract project quality output

	N	Mean (\bar{x})	Std. deviation (σ)
Project incorporated innovative practices	267	3.33	0.789
Project conform to specifications	267	4.01	0.642
Outcomes are durable and long-lasting	267	4.08	0.723
Outcomes comply with regulatory standard	267	3.86	0.722
Stakeholder satisfaction	267	4.02	0.756
Quality of workmanship	267	4	0.577
Mean of Construct		3.88	

Performance in terms of overall quality of output, mean score \bar{x} = 3.67 suggests that the overall quality of output was rated between “Moderate “ and “ Good “ The standard deviation σ = 0.694 reflects moderate variability, indicating that most projects were perceived to deliver high-quality outputs, with some variability in performance. Regarding compliance to safety standards of the outputs, the participants on average (arithmetic mean), \bar{x} = 3.53 indicates that compliance with safety standards was rated between “Moderate “ and “Good.” The standard deviation σ = 0.781 shows some variability, indicating differences in adherence to safety standards across projects. On utilization of resources with a mean, \bar{x} = 3.91, resource utilization was rated closest to “Good,” suggesting efficient and effective use of resources in most projects. The low standard deviation σ = 0.625 indicates consistent perceptions of high resource utilization efficiency.

Overall performance

The average performance, mean, \bar{x} = 3.504 ratings across all attributes suggest that the construction projects generally performed well, with particular strengths in resource utilization and quality of output. However, there are areas for improvement in time performance and, to a lesser extent, financial performance. The results are summarized in Table 5.

Table 5 Overall contract performance

	N	Mean	Standard deviation
Financial performance	267	3.41	.658
Time performance	267	3.00	.831
Overall Quality of Output	267	3.67	.694
Project’s Compliance with Safety standards	267	3.53	.781
Project’s utilization of resources	267	3.91	.625
Construct mean (\bar{x})		3.504	

Inferential statistical analysis

The data on the variables of the study was collected in categories, making them categorical variables measured in ordinal scale.

Additionally, the comparison was made between only two groups (Single prime contracting and Multi prime contracting). Consequently, the data could not be tested for normality to guide on the sample t-tests. Inferential statistics was thus executed by running **Mann-Whitney U Test** to compare the performance of the two contracting methods under study based on Construction Costs, Construction Project Timeline, Quality of Project Output and overall contract performance (financial, quality, timeliness, compliance with safety standards and resource utilization). A Mann-Whitney U Test was employed to analyse the data from 83 construction projects (49 Single Prime and 34 Multi prime). The results provide valuable insights into the relative strengths and weaknesses of each contracting method. The analysis was summarized as captured in Table 6 and 7 below.

Table 6 Ranks

	Contacting method of the most recent project	N	Mean rank	Sum of ranks
Quality of project output	Single prime	147	38.91	5719.91
	Multi prime	102	46.46	4,738.92
	Total	249		
Overall contract performance	Single prime	147	39.32	5780.04
	Multi prime	102	45.87	4678.74
	Total	249		

Table 7 Test statistics*

	Quality of project output	Overall contract performance
Mann-Whitney U	495.000	701.500
Wilcoxon W	1090.000	1926.680
Z	-1.152	1.228
Asymp. Sig. (2-tailed)	.002	.019

Mann-Whitney U test

A statistically significant difference was observed in the quality of project output between Single Prime and Multi prime contracting methods ($U = 495.0$, $z = -1.152$, $p = 0.002$). The significantly higher mean rank for Single prime (38.91) compared to Multi prime (46.46) indicates that Multi Prime contracting is associated with higher quality project outputs. This finding is particularly noteworthy and may be attributed to the competitive determination of the various contractors in Multi prime contracting, potentially leading to better higher quality standards. The significant advantage of Multi prime contracting in project quality output is a crucial finding. It suggests that organizations prioritizing high-quality deliverables might lean towards Multi prime contracting. This advantage could be due to clearer lines of responsibility and more dedication to outcompete fellow contractors in the same project.

Overall contract performance

The difference in overall contract performance between the two methods was not statistically significant ($U = 701.500$, $z = -1.228$, $p = 0.019$). Interestingly, despite the seemingly lower quality output, Multi prime contracting showed a slightly higher mean rank (45.87) compared to Single Prime (39.32) in overall performance, though this difference did not reach statistical significance. This suggests that factors other than quality might be influencing perceptions of overall performance in Multi prime projects. The significant advantage of Multi Prime contracting in overall performance, combined with its construction costs, presents a strong case for this method. However, this must be balanced against the longer times and lower quality associated with Multi Prime projects.

Independent sample t-test - mean differences

This study employed an independent samples t-test to compare Single Prime and Multi-prime contracting methods across two key variables; quality of project output, and overall contract performance. The sample consisted of 49 Single Prime projects and 34 Multi prime projects. Table 8 summarizes the results of the analysis.

Table 8 Group statistics

	Contacting method of the most recent project	N	Mean	Standard deviation	Standard error mean
Quality of project output	Single Prime	147	3.8449	.3221	.04602
	Multi prime	102	3.9588	.2868	.04918
Overall contract performance	Single Prime	147	3.4571	.4743	.06776
	Multi prime	102	3.5632	.4239	.07268

The analysis of project output quality showed no statistically significant difference between single prime ($\bar{x} = 3.8449$, $\sigma = 0.32214$) and multi-prime ($\bar{x} = 3.9588$, $\sigma = 0.28675$) projects; $t(81) = -1.656$, $p = 0.102$. The mean difference of -0.11393 (95% CI: -0.25081 to 0.02295) suggests a slight trend towards higher quality in multi-prime projects, but this difference was not statistically significant. This finding is interesting as it indicates that the contracting method may not significantly impact the final quality of the project output. It suggests that other factors, such as the expertise of the contractors, the quality of oversight, or the specifications of the project, may have a more substantial influence on the final quality than the contracting method itself. Although these results portray Multi-prime as favorable where quality is the ultimate priority, caution should be taken to integrate all other critical factors in decision making.

There were observable difference for the significance of differences between the two contracting methods when Mann-Whitney U test and independent sample T-test result are compared. The possible explanation is that Mann-Whitney U test is detects difference in the entire distribution in terms of shape, spread and median while Independent sample T-tests only compares means and assumes normal distributions. Additionally, Mann-Whitney U, users ranks and therefore less affected by outliers while and more sensitive to outliers which may mask true differences in t-tests. Mann-Whitney U test results are thus more robust for non-parametric data and reliable when establishing differences between groups (Table 9).

The findings of this study partly coincide with those of past studies indicating that Multi prime contracting is associated with higher quality of output. Some of the explanation is these studies include the perceived higher degree of specialization in the case Multi prime contracting. Oyetunji and Anderson,³⁷ found that Multi prime contracting allows for the selection of specialists for each aspect of the project, potentially leading to higher quality in specific areas. Additionally, other studies observed that Multi prime contracting often involves more direct owner involvement, which can lead to improved alignment with owner quality expectations.⁴² Moreover, the involvement of multiple prime contractors creates a system of checks and balances, potentially catching and addressing quality issues more effectively quality.¹³

Other studies have however noted contrary trends. Konchar and Sanvido⁴¹ for example argued that Single prime contracting leads to better quality due to centralized responsibility for the entire project. The prime contractor has a holistic view of the project, potentially

leading to better integration of different elements. Molenaar and colleagues⁴⁰ suggested that Single prime contracting simplifies quality control processes, as there's a single point of responsibility for overall

quality. Having one prime contractor may lead to more consistent application of quality standards across the project.^{21,31}

Table 9 Independent sample test

		Levene's test for equality of variances		t-test for equality of means				95% Confidence interval of the difference		
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error difference	Lower	Upper
Quality of Project Output	Equal variances assumed	1.515	0.222	-1.656	81	0.102	-0.11393	0.06879	-0.2508	0.023
	Equal variances not assumed			-1.691	76.023	0.095	-0.11393	0.06735	-0.2481	0.0202
Overall contract performance	Equal variances assumed	0.465	0.497	-1.046	81	0.03	-0.10609	0.10143	-0.3079	0.0957
	Equal variances not assumed			-1.068	75.886	0.029	-0.10609	0.09937	-0.304	0.0918

Conclusion and recommendations

From the results of the analysis, this study concludes that multi-prime contracting methods is superior in quality performance of outcomes than single-prime. Quality output of multi primes performs better than that of single-prime contracting methods in term overall performance in large and complex road infrastructure construction projects in Nairobi City County-Kenya. The conclusions notwithstanding, the choice between single-prime and multi-prime contracting method should be based on a cautious regard of project priorities, the balance between the need for quality performance against cost and overall performance thresholds. The study underscores the importance of aligning contracting methods with specific project deliverables goals and clients and/or contractor capabilities.

This study recommends that in the era of intensive road infrastructure construction projects being launched in the country, premeditated consideration should be made to assess all the facets of roads infrastructure construction contracts so that the best contracting methods is employed to take ensure quality is delivered to realize the value for money. This study for example indicates that multi prime contracting method performs better that single prime overall, and in terms of quality, and therefore recommends that governments agencies should consider multi-prime contracting methods above single-prime contracting method where overall quality is of a higher priority. However care should be taken to ensure that strong and seamless coordination mechanism to manage the fragmented control over resources so that risk conflicts, delays and inconsistent quality are arrested in time and least cost possible. Where bureaucratic process poses increased risk of delays and conflicts and the work to be delivered does not requires a large scope of trades, Single Prime contracting would be preferable.

The findings of this study contribute substantially to the body of knowledge in construction contract management and offer useful intuitions for project managers, stakeholders, and policymakers, and clients in the construction industry. This study suggest that future

studies should consider researching on establishing more advanced and long terms roads infrastructure quality measurement thresholds from which contractors can be held accountable.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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